THE ADVANCE OF BIOLOGY IN 1895.

By C. B. Davenport.

The publication of *L'Année biologique* for 1895, which is described in another column, gives us an opportunity to make use of the admirable summaries of the chapters to summarize still further the advance of general biology in 1895.

Cytology.—The group of unnucleated organisms was still further diminished by Nadson's discovery in Cyanophyces of chromatin-like granules diffused throughout the cell, but arranging themselves during cell division in a way recalling karyokinesis. The idea of the permanent nature of the centrosome in the cell was strengthened by finding it in resting cells of many plant and animal tissues. The identity of centrosome and nucleolus in the infusorian *Spirochona* was insisted upon by Balbiani.

In the study of cell-division we find the year characterized by the variety of material employed—the attempt to build up a broader comparative knowledge upon the basis of well-studied types. The nuclear origin of the spindle was strongly maintained by Strasburger and others against the prevailing view. New variations in the method of splitting of the chromosomes were described. The mechanical (rather than the magnetic or chemotatic) explanation of the intracellular movements seemed to gain favor. The nature of the archoplasm, whether a part of the cytoplasm or different, was left in debate. New intermediate conditions uniting direct and indirect nuclear division were described and the great variety in the karyokenetic process was becoming generally recognized.

The sexual products and fecondation.—The question of chromatic reduction before the introduction of new chromatin by fertilization attracted many workers, and new data were obtained on the number of chromosomes in different species, the time at which reduction takes place and the details of the method. New methods of formation of the tetrads by conjugation were described by Wilcox, Calkins and others.

In our knowledge of *fecondation* great advance was made, largely by American workers. The derivation of the archoplasm of the fertilized egg exclusively from the sperm was confirmed upon many organisms; but Wheeler found in Myzostoma a case of the persistence of the archoplasm of the ovum only. The independence of the nuclear matter derived from the two germ cells united in fecondation was shown by Rückert to be indicated in Cyclops by the bilobed condition of the nucleus, even to the period of formation of the germ layers.

Parthenogenesis.—The accepted view that the unfertilized hen's egg may go through the early cleavage stages was shown by Barfurth and by Lau, independently, to rest upon errors in observation.

Ontogenesis—The contributions to the preformation-epigenesis controversy were among the most important of the year, pointing to a common ground for both sides, one, consequently, which probably lies near the truth. Driesch and Morgan, opponents of Roux's form of the theory of preformation, found in the Ctenophore an organism in which, when one of the two blastomeres is isolated, the other develops into a partial larva. This indicated a degree of preformation, but not the degree held by Roux; for, first, more than half of the larva was produced from the $\frac{1}{2}$ blastomere, and, secondly, when a piece was cut out of the fertilized but unsegmented egg, there was still a defect in the larva. The conclusion was: There is a rough preformation in the *cytoplasm*, but not, in addition, a qualitative divison of the nucleus as Roux supposes. On the other hand, Zoja found that a whole medusa developed from even a $\frac{1}{16}$ blastomere. We must recognize, consequently, a series in the capacity of developing a whole from a part, of which the medusa occupies one extreme and the ctenophore the other. Studies on amphibian eggs were made by Morgan, who found that half or whole embryos may be obtained from the $\frac{1}{2}$ blastomere, according as the contents of the egg preserve their normal positions or become intermingled by inverting the egg, and by Herlitzka, who found that the isolated $\frac{1}{2}$ blastomere of Triton develops like the entire egg. All the facts seemed to

point to a combined action of epigenesis and evolution in development.

The limiting size of the egg consistent with development was studied by Morgan, who found that one-fiftieth of an uncleft echinoid egg would develop, and by Loeb, who believed one-eighth of the total mass of the egg is necessary to the formation of the pluteus, while, in the presence of nucleoplasm, the very smallest quantity of cytoplasm is capable of growth and organization.

The theory that development is controlled by responses to stimuli was extended by Herbst and by Davenport to particular developmental processes. Roux brought forward his observations on the migration of isolated blastomeres with reference of each other—cytotropism; these migrations resembling those of zoospores towards and from each other (Hartog, Sauvageau). Advance was made in interpreting, on the ground of functional activity, the details of the form of the skeleton (Hirsch) and especially of the joints (Tornier).

Teratogenesis.—Double monsters were produced in frogs by inversion, which mixes up the contents, and in echinoids, by immersing the egg in a salt solution and thereby producing an "extraovat." The effects of low temperature upon development were studied in detail upon frogs and the chick; magnetism was shown again to have little or no effect upon development, while electricity has (Windle); abnormal density of solutions caused spina-bifida and other abnormalities in the tadpole (Hertwig, Gurwitsch). The capacity for development of enucleated egg-fragments into which a spermatozoan has penetrated was reasserted, as a result of new studies, by Boveri.

Regeneration.—Progress was made along three lines: the distribution of the capacity for regeneration, the comparison of regeneration and ontogeny, and the explanation of regeneration. As for the distribution of the regeneration capacity, new cases were described of the regeneration of internal organs (spleen of rabbit, liver of mammals)—not subject to accidental amputation. Failure to regenerate was reported of the thyroid gland and nerve cells in vertebrates. Experiments revealed a capacity for regeneration in the nervous system of earthworms,

the trunk segments of pantapods, and the body of ascidians. It became clearer that regeneration may proceed along very different lines from normal ontogeny—Wolff found the crystalline lens regenerating from the edge of the iris instead of the outer skin. Girard found that well-fed and much exercised tritons regenerate polydactylic feet.

Concerning the cause of regeneration, Nussbaum concluded that both regeneration and heteromorphosis depend upon indifferent cells in the body; Loeb suggested that regeneration depends upon special organogenic substances (Sachs); and Rauber compared in much detail organic regeneration to that of a crystal and believed a causal relation to lie behind the similar phenomena.

Grafting.—This year will be remembered as that in which Born published the results of his marvelous experiments on uniting bits of tadpoles belonging even to different families. Important also are the experiments of Wetzel who obtained from his grafts of hydra additional evidence for the polarity theory.

Polymorphism, metamorphosis and alternation of generations.—Advance was made (1) in the interpretation of many varieties as polymorphic forms; (2) in the determination of polymorphic forms by external conditions, and (3) in the discovery of a hidden alternation of generations in organisms. For the first, Coutagne showed for molluscs and Standfuss for mosses that similar varieties, due to the same causes, recur so frequently in different species that a few suffixes applied to the different specific names will suffice to designate all varieties. As for the second, Dietel showed that, in the Uredineæ, the succession of aecidio-, uredo- and teleutospores may be varied at will; Wasmann got intermediate polymorphic forms in ants by intermediate food conditions, and Bachmann modified, by changing the character of the substratum, the form of the sporangia of *Thamnidium.* As for the third, the idea of Strasburger (1894) was developed by others, so that the theory now seems well formulated that, as in the vascular cryptogams and the phanerogams, so also in all animals there is an alternation of generations, the sexual generation including the

four cells arising from the oögoumni—a rudimentary generation corresponding to the rudimentary sexual generation of angiosperms—and a non-sexual generation, which comprises the soma, each of whose nuclei has double the number of chromosomes found in the sexual generation.

Correlation.—The development of the doctrine of internal secretions was the most important contribution of this year to the theory of correlation. Especially were the effects on other organs of the removal of the sexual glands, the thyroid, the superrenals, and the digestive glands carefully studied; and the obliteration of these effects, by feeding extracts of the tissues, observed. The specific action of one part of the organism upon the other parts was being unravelled.

General morphology and physiology.—This year witnessed the memorable discussion between A. Sedgwick and Bourne as to the morphological value of "cells," which served to emphasize their physiological significance. To the subject of budding we have the contributions of Chun, who showed that, in the medusæ, both layers of the bud may be derived from one layer only (the ectoderm); thus another blow was dealt to the germ layer theory.

Especially memorable was the year for the appearance of Verworn's "Allgemeine Physiologie," which, in one leap, gave scientific standing to that subject, and of LeDantec's "La matiére vivante," much less extensive, but in the ground it covers, more profound; both works are dominated by the idea of the chemical nature of vital phenomena. The numerous papers on general physiology related to various subjects, especially general cell-physiology, muscle contraction, phagocytosis, effect of external agents on organisms, geotropism (Czapek), heliotropism, thermotropism (Mendelssohn), nutrition, cell respiration (Loeb and Hardesty), immunity, toxines and ferments.

Heredity.—The year saw much discussion of the inheritance of acquired characters and the theory of heredity, but little progress. The experiments of Charrin and Gley afforded another example of transmission (but rare and incomplete) to the first generation of the effects of vaccination. Hyatt pub-

lished in full his palæntological evidence that an impression in the shell of fossil Ammonites, due to crowding of coils, persists in (abnormally) uncoiled species. A masterly discussion of the whole question of inheritance of acquired characters appeared this year in Romanes' "Post-Darwinian Questions."

Variation.—If little new was added to our knowledge of heredity, such was by no means the case with variation. New facts were acquired, new methods of study employed, new experimental investigations made to determine its cause.

Osborn classified variations as ontogenetic (and either gonagenic, gamogenic, embryonic or somatogenic) and phylogenetic. Scott distinguished between individual variation (of ontogenetic value only) and mutation (of phylogenetic value).

Mehnert showed that variation occurs as abundantly in embryos as in adults. Eigenmann showed that in certain fishes the variants above the mode are more abundant than those below, and that individual variation is greatest where the number of species is greatest. The extraordinary variation of medusæ was investigated by Browne.

The development of the mathematical study of evolution, for which this decade will ever be famous, took a great stride in the publication of Pearson's "Skew Variation," by which methods of measuring unsymmetrical variation curves, their variability and their skewness were given. Since most biological curves are skew curves, this method greatly extends Galton's, which was applicable only to symmetrical curves. DeVries studied quantitatively a case of dimorphism in plants, and Weldon investigated selection in crabs.

Among the studies on the causes of variation may be mentioned the experiments of Vernon on echinoderm larvæ; of Weismann, Standfuss, Ris and, especially, Fischer (similar effect on heat and cold), upon lepidoptera; of Bonnier on plants subjected to electric light (producing excess of chlorophyll and scragged form); and of Goebel, who found that when cacti with foliaceous stems were grown in the dark the stems became rounded. Davenport and Castle found that tadpoles have the capacity for self-adaptation to heat.

As for variation due to internal causes, Meyer determined that despite its fewer chromosomes, *Ascaris univaleus* is as variable as *A. bivalens*, which is opposed to Weismann's theory. Brooks pointed out apropos of amphimixia that the number of ancestors of an individual does not roll up according to the formula 2^n (in which the power ^{n} represents the number of generations) because of constant intercrossing of relatives.

Origin of species.—A trend towards facts is clearly discernable in the work of the year on this subject. Natural selection was tested by the statistical method (Weldon). Galton called for facts concerning sports and their pedigree, a call which should not be unheeded by American naturalists. One such case, excellently traced, was given in 1895 by Tracy in the AMERICAN NATURALIST. Aerial discussions still went on, however. Wallace still thought that specific differences arise by the summation of slight variations, and Henslow still maintained the view that they arise from considerable self-adaptive changes.

Mental functions.—The differentiation of comparative physiological psychology from "metaphysics" made good progress during 1895. Lloyd Morgan did much to give to instinct a satisfactory biological definition. Among special works on the senses of animals may be mentioned the Peckhams' observations, showing that spiders recognize each other by sight, and Riley's experiments with moths, in which a marked male found a female a mile and a half away. Hodge and Aikins gave the records of the activities of a single Vorticella observed during several consecutive hours.

Studies in the ontogenesis of mental functions were made by Mills on the dog, and he and Lui agreed that there is a close parallel between the appearance of certain functions and the visible development of corresponding cortical centres. Baldwin had followed carefully the mental development of a child and laid great stress upon the rôle of imitation in the process. The development of memory, especially visual memory, and the formation of abstract concepts were also studied.

General theories.—This year was productive of no new guiding theories. It was still reasserted that it is vain to seek

further than for a teleological explanation of biological phenomena. Weismannism was much attacked and much mended. Cope issued several articles foreshadowing his now well-known book. Whitman showed from the history of the discussion, epigenesis *vs.* evolution, how the grounds of debate have completely changed.

In glancing over the work of the year, we see that the great advances were made in cytology in the broad sense, in the interpretation of the causes of the early ontogenetic changes, in the general physiology of organisms, in the experimental determination of form and in the quantitative study of variation. All of these are subjects little considered a decade or two ago. It is noticeable also that, although general biology has long been regarded as a free field for all speculators, the greatest activity among workers and the richest results are found when the students of fact are busy. This is the most hopeful sign for the future.

THE SWAMPS OF OSWEGO COUNTY, N. Y., AND THEIR FLORA.

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THE LAKES.

In the region of our typical swamps these lakes are frequently of considerable depth. Usually, however, they are comparatively shallow. Stories are told here, as elsewhere, of "bottomless lakes" where a line, no matter how long, would not reach the bottom. The fine mud in the bottom was, in all probability, the cause of the deception. At the bottom of the lake the mud is as mobile as water, and it is difficult to determine where fluid ends and solid begins, and hence the difficulty in sounding. There are at least three lakes in this region called Mud Lake, a fact which testifies to their character. One is Mud Lake in Oswego town already described, another is in Scriba in the same county two or three miles south of the